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Fred Burr Reservoir Dam, Victor, Ravalli County, Montana, MT-763

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

FRED BURR RESERVOIR DAM
VICTOR, MONTANA
RAVALLI COUNTY
MT-763

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PREPARED FOR:

HONORABLE THOMAS L. JUDGE
GOVERNOR, STATE OF MONTANA

STATE OF MONTANA
(OWNER AND OPERATOR)

PREPARED BY:
CH2M HILL
BELLEVUE, WASHINGTON

JULY 1980

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

FRED BURR RESERVOIR DAM
VICTOR, RAVALLI COUNTY, MONTANA
MT-763

PREPARED FOR

HONORABLE THOMAS L. JUDGE

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SEATTLE
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EXECUTIVE SUMMARY

Under contract with the Seattle District Corps of Engineers, and with representation from the Corps, the State of Montana Department of Natural Resources and Conservation, and the U.S. Forest Service, CH2M HILL inspected Fred Burr Reservoir Dam on July 18, 1979, under the authority of Public Law 92-367. The dam is located on Fred Burr Creek in Ravalli County, about 9 miles southwest of Victor and 10 miles northwest of Hamilton, Montana.

This report was compiled from information obtained during an onsite inspection, from review of construction plans, and from analysis of available hydrologic information.

Findings

Fred Burr Reservoir Dam is owned and operated by the State of Montana. The dam and reservoir are located on public land administered by the U.S. Forest Service. Principal use of the project is for the storage of irrigation water. Use of national forest land for such purposes is through special use permits issued by the U.S. Forest Service.

The 50-foot-high earth dam impounds 690 acre-feet of water at assumed top of dam, elevation 5148.8 feet National Geodetic Vertical Datum (NGVD). On the basis of criteria in U.S. Army Corps of Engineers "Recommended Guidelines for Safety Inspection of Dams" (Ref. 1), the project is intermediate in size.

At this time, the project is classified as having a low (Category 3) downstream hazard potential. Inspection criteria (Ref. 1) recommend that an intermediate-size project with a low downstream hazard potential be capable of safely handling a flood in the range from the 100-year flood to one-half the probable maximum flood (PMF). The PMF is the flood expected from the most severe combination of meteorologic and hydrologic conditions that are reasonably possible in the region.

An estimated PMF was developed for the 11.8-square-mile drainage basin. The PMF resulting from the 6-hour thunderstorm has an estimated runoff volume of 4,400 acre-feet. The spillway has a maximum discharge capacity of 1,900 c.f.s. with the reservoir at dam crest and the spillway tainter gate open and 860 c.f.s. with the gate closed.

Estimates indicate that the dam is overtopped during the PMF when approximately 10 percent of the total flood volume enters the reservoir with the spillway gate open and 5 percent with the gate closed. Thus, Fred Burr Reservoir Dam will be overtopped by floods significantly smaller than the PMF.

The dam is constructed of materials that would quickly erode and rapidly fail when overtopped by floodwaters. A visual inspection of the embankment and abutments revealed no cracks, irregularities, or slumps. Erosion from surface runoff is present along the right wall of the spillway. No seepage was observed on the abutments or downstream toe. There is no information on how the embankment was actually constructed, or on strength characteristics of embankment materials; therefore, stability cannot be evaluated.

Recommendations

Because of the low downstream hazard potential of the Fred Burr Reservoir Dam, the complete Phase I inspection report required by the Recommended Guidelines (Ref. 1) was not prepared. Instead, general recommendations are to more fully evaluate the downstream hazard potential, taking into consideration future development, and to improve the outflow capability commensurate with downstream risk. Also, periodic inspections of Fred Burr Reservoir Dam and the upstream Fred Burr Lake Dam (MT-838) are recommended. Failure of Fred Burr Lake Dam could cause overtopping and failure of Fred Burr Reservoir Dam.

MONTANA
RICHARD L.
FOSTER
2646 E
REGISTERED
PROFESSIONAL ENGINEER

Richard L. Foster
Professional Engineer

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PERTINENT DATA

1. GENERAL

Federal ID No.	MT-763
Owner and Operator	State of Montana
Construction Date	1948 (original), 1949-50 (assumed rebuilt)
Purpose	Irrigation
Location	Section 14, T7N, R22W Principal Meridian
County, State	Ravalli, Montana
Watershed	Fred Burr Creek, tributary of Bitterroot River
Downstream Hazard Potential	Category 3 (low)
USGS Quadrangle	Printz Ridge

2. RESERVOIR

Surface Area at Spillway Crest	28 acres
Drainage Area	11.8 square miles
Storage at Spillway Crest	410 acre-feet
Top of Gate	516 acre-feet
Storage at Dam Crest	690 acre-feet
Surcharge Storage (gate to crest)	174 acre-feet

3. SPILLWAY

Type	Chute with 4.3-foot-high, 5-foot-radius tainter gate
Bottom Width	20 feet
Crest Elevation	5139 feet NGVD

Capacity with Reservoir at Dam Crest	
Gate open	1,900 c.f.s.
Gate closed	860 c.f.s.

4. OUTLET WORKS

Control Tower	Wet well
Conduit	48-inch-diameter RCP
Conduit Length	196 feet
Valves	48-inch-diameter slide gate
Capacity with Reservoir at Dam Crest	410 c.f.s. (estimated)

5. DAM

Type	Rolled earthfill
Length	325 feet
Crest Width	15 feet
Crest Elevation	5148.8 feet NGVD
Hydraulic Height (Crest to toe)	50 feet
Upstream Slope	1 V on 2.25 H
Downstream Slope	1 V on 2 H (upper) 1 V on 4.0 H (lower)

ABBREVIATED PHASE I INSPECTION REPORT

INSPECTION

Personnel of CH2M HILL, with representation from the State of Montana Department of Natural Resources and Conservation (DNRC), the U.S. Army Corps of Engineers, and the U.S. Forest Service, inspected Fred Burr Reservoir Dam (MT-763) on July 18, 1979. The dam is located (Section 14, T7N, R22W, Principal Meridian) in Ravalli County, Montana, about 9 miles southwest of Victor and 10 miles northwest of Hamilton. The dam is owned and operated by the State of Montana for storage of irrigation waters. The dam and reservoir are located within the Bitterroot National Forest. The private use of the reservoir for irrigation water storage is through a special use permit issued by the U.S. Forest Service.

According to criteria in the U.S. Army Corps of Engineers "Recommended Guidelines for Safety Inspection of Dams" (Ref. 1), the project is intermediate in size. Before the inspection, there was some question about the downstream hazard posed by this dam. After the dam inspection, a reconnaissance of the area downstream of the dam was made by Art Taylor from the State of Montana DNRC and a U.S. Forest Service representative (Ref. 2), and it was found that failure of the dam would cause little damage. Therefore, the project is classified as having a low (Category 3) downstream hazard potential. Inspection criteria recommend that an intermediate-size project with a low downstream hazard potential be capable of safely handling a flood in the range of from the 100-year flood to one-half of the probable maximum flood (PMF). A preliminary estimate of the PMF shows that the dam will be overtopped during the PMF when less than 10 percent of the flood volume enters the reservoir (with spillway gate open). No estimate was made on what recurrence interval this flood would have.

This report recommends further study to better evaluate the downstream hazard and to determine the proper spillway design flood. The downstream hazard potential should be periodically reevaluated, since future development near the creek may be affected by a break of Fred Burr Reservoir Dam.

Those present during the inspection included:

Miles Bubenik - CH2M HILL Geotechnical Engineer and Team Leader

Jerry Jacksha - CH2M HILL Geotechnical Engineer

Loren Bottorff - CH2M HILL Hydraulics Engineer

Captain Don Warner - U.S. Army Corps of Engineers

Art Taylor - State of Montana Department of Natural Resources and Conservation

Alex Bailey - State of Montana Department of Natural Resources and Conservation

Ron Volden - U.S. Forest Service

Dick Judge - U.S. Forest Service

Because of the low downstream hazard potential of Fred Burr Reservoir Dam, the normal complete Phase I inspection report was not prepared.

This report has been reviewed by the State of Montana Department of Natural Resources and Conservation and the U.S. Forest Service. Their comments, if any, are included in the Appendix.

Description of Project

Fred Burr Reservoir Dam is located near the headwaters of Fred Burr Creek, a tributary of the Bitterroot River, in Ravalli County, Montana, approximately 10 miles northwest of the town of Hamilton (see Plate 1). The dam is currently listed as having a low downstream hazard potential. Its Federal identification number is MT-763. The 50-foot-high dam impounds 690 acre-feet at dam crest, assumed elevation 5148.8 feet NGVD.

The 120-foot-long spillway chute is located on the right abutment, shown on Plate 2. A 48-inch concrete outlet, with a 48-inch-diameter slide gate and gate controls at the dam crest, is used for irrigation releases.

Principal use of the 28-acre reservoir is irrigation storage.

This dam is not to be confused with Fred Burr Lake Dam located upstream of Fred Burr Reservoir Dam.

Regional Geology and Seismicity

The area geology and seismicity of Fred Burr Reservoir Dam was addressed in a memorandum by R. D. Eckerlin (Ref. 3). The following is taken from the memorandum:

> Fred Burr Reservoir Dam, lies on Fred Burr Creek on the eastern flank of the Bitterroot Range within the Northern Rocky Mountains physiographic province. The Bitterroot Range is composed mostly of late Cretaceous igneous rocks of the Idaho Batholith. The batholith is divided by the Salmon River Canyon into the Bitterroot Lobe on the north and the Atlanta Lobe on the south. A zone of major left lateral translation known as the Lewis and Clark Line, which is a part of the Montana Lineament, tectonically

divides the Northern Rocky Mountains into a Northern and a Southern Province. The Southern Province is broken into several discrete elements, including the Idaho Batholith and Sapphire Detachment Block, which are separated by the north-south trending, structurally controlled, Bitterroot Valley. The Lewis and Clark Line has acted as a fundamental tectonic dividing line since the Precambrian. Fred Burr Reservoir lies about 40 miles south of the Lewis and Clark Line in a region of extremely varied and complex geology. Structural features in the region are a series of nearly parallel thrust faults, which trend in an east-southeast direction and cut across older structures of the Laramide deformation having a north-south trend. Thrust faulting is the dominant type of rock failure in the region and is assumed to have been caused by north-northeastward directed forces. Evidence of Pleistocene alpine glaciation can be seen in the Bitterroot Range in the form of cirques, moraines, and glacial debris extending down the valleys.

The dam lies in Zone 2 of the Seismic Zonation Map of Continuous States (TM5-809), shown in the Recommended Guidelines (Ref. 1). In this zone, moderate damage can be expected from earthquakes. The dam is adjacent to the seismically quiet Bitterroot Valley. Based on historic seismicity, little risk is expected. Algermissen (Ref. 4) estimates a 90 percent chance of 0.04 g acceleration being felt at this dam in a 50-year period.

Site Geology

There is no geologic report or subsurface information on file for this site. The available information suggests that most of the dam is founded on glacial deposits consisting of silts, sands, and gravels underlain by rock. Shallow test pits less than 5 feet deep (Ref. 5) were dug along centerline and found the foundation material "free of porous stratifications." An observation (Ref. 5) of the channel erosion during the 1948 dam failure found the eroded channel approximately 12 feet below the original creek bed. Therefore, it is likely that bedrock is at least 12 feet below embankment base. The left abutment is a rock talus slope, and the right abutment is a moraine terrace.

Design and Construction History

The original 37-foot-high Fred Burr Reservoir Dam was designed under the supervision of the State of Montana Water Conservation Board. Construction began in 1946; with the exception of the spillway, the embankment was completed in the winter of 1947, when work was halted because of weather. On May 27, 1948, during high runoff (reservoir 3 feet above excavated entrance to the spillway) before work had resumed on the spillway, the dam was breached on the right (south) side in the area of present spillway.

Although no date is given, the dam probably was reconstructed the summer of 1949 or 1950. The existing embankment is 50 feet high. Most of the low-level conduit was left intact by the dam failure. Near the downstream end of the original conduit, the conduit was extended under the reconstructed portion of the embankment, and a new outlet structure was built. The present spillway probably was also constructed during the summer of 1949 or 1950. Design of this reconstruction was performed under supervision of the State of Montana Water Conservation Board, and only the plans are available. There are no construction specifications, material testing results, stability analysis, or construction records available.

Spillway

The spillway is located at the right abutment of the dam. The spillway consists of a 20-foot-wide, rectangular concrete chute controlled by a 4.3-foot-high tainter gate. The approach channel is short, wide, and unobstructed. A log boom is located in the reservoir just upstream from the approach channel. The abutment walls extend upstream from the crest at 30 degrees to the direction of flow. The tainter gate has a radius of 5 feet and is formed of corrugated metal supported by a steel frame. The hand crank gate hoist is located on the left (looking downstream) spillway wall. The hoist turns a shaft that crosses the spillway and lifts the gate by winding cables attached to the ends of the gate.

The crest of the spillway is at assumed elevation 5139 feet NGVD, 9.8 feet below the low point on the dam crest. The top of the tainter gate, in the closed position, is at assumed elevation 5143.3, 5.5 feet below the low point on the dam crest. The slope of the chute changes from level at the spillway crest to 0.4 approximately 30 feet downstream of the crest. The chute continues on the 0.4 slope for approximately 90 feet to the stilling basin. The stilling basin is a 12-foot-long roller bucket. The downstream channel and toe of the dam are heavily riprapped and are neither eroding nor backcutting.

The reservoir level was about 0.1 foot above the top of the spillway gate at the time of the site visit. A slight disturbance of sheet flow in the spillway crest was observed at the expansion joints, indicating slight displacement or loss of joint material. The spillway concrete appeared to be in very good condition. Some erosion, caused by drainage from a side ravine, was observed along the right (looking downstream) spillway wall.

The spillway discharge rating was developed with the tainter gate up and assuming that critical depth occurs about 4 feet upstream from the gate where the spillway becomes fully constricted to 20 feet wide. The maximum discharge capacity of the spillway, with the reservoir at the crest of the dam, was

estimated to be 1,900 c.f.s. A second discharge rating was developed with the gate closed. The weir-head discharge relationship was used with a constant discharge coefficient of 3.32. The maximum discharge capacity with the gate closed was estimated to be 860 c.f.s.

Outlet Works

The outlet works is located through the embankment near the center of the dam. The intake structure could not be inspected because of the reservoir level, but the construction plans show it as a pair of convergent wing walls fitted with a trashrack. The 48-inch-diameter, reinforced concrete outlet conduit extends approximately 64 feet (on unknown slope) from the intake structure to the wet well gate tower. The gate tower is near the dam axis, and the control for the 48-inch-diameter slide gate is at the top of the tower. The control and hand crank are chained and locked. The control is exposed to the weather but appeared to be in good condition. A 6-inch-diameter vent pipe extends from the top of the tower to the conduit just downstream of the wet well.

The 48-inch-diameter conduit extends approximately 132 feet from the wet well to the outlet structure. This reach of conduit contains three horizontal bends of approximately 15 degrees each and one vertical bend of approximately 15 degrees. The outlet structure consists of a floor slab with divergent wing walls. A slight undercutting of the floor slab was observed. The downstream channel contained much riprap and was in very good condition. The outlet conduit was entered through the downstream end during the site visit, and inspection was made to the gate. The conduit appeared to be in good condition, with only minor cracking. Patches at various locations within the conduit were holding well.

The discharge rating of outlet works was developed with the gate fully open. A Mannings "n" of 0.013 was used to estimate friction losses with the conduit flowing full. The maximum discharge capacity of the outlet works, with the reservoir at assumed top of dam, elevation 5148.8 feet NGVD, was estimated to be 410 c.f.s.

Freeboard

The vertical distance between the low point on the dam and the reservoir level at the time of the inspection was 5.4 feet. During the inspection, water 0.1 feet deep was flowing over the top of the spillway tainter gate. The effective fetch for wind-generated waves is less than 1,000 feet, and wave runup on the embankment is estimated to be less than 2 feet. The dam will overtop and have no freeboard during floods significantly less than the probable maximum flood (PMF), but the vertical distance between the dam crest and the normal reservoir

level is adequate to prevent overtopping of the embankment by wind waves. The upstream slope of the embankment is well riprapped and protected from erosion.

Hydrology

The drainage basin area for Fred Burr Reservoir Dam is approximately 11.8 square miles, is roughly oval in shape, and is about 70 percent forested. Most of the drainage area is located within the Selway-Bitterroot Wilderness Area. The basin is very steep, and much of it is exposed bedrock. Basin elevations range from 5140 NGVD at the dam to 8984 NGVD at Castle Crag on the southern boundary. Fred Burr Creek flows approximately 6 miles from Fred Burr Lake Dam (MT-838), in the upper reaches of the basin, to Fred Burr Reservoir. Records indicate that this upper dam has a maximum height of 25 feet and a maximum storage of 250 acre-feet. A failure of Fred Burr Lake Dam (MT-838) may cause overtopping and failure of Fred Burr Reservoir Dam (MT-763), since only about 174 acre-feet of surcharge storage is available in Fred Burr Reservoir between the top of the spillway gate and the top of the dam.

The climate of the area is modified continental in nature, characterized by warm summers, cold winters, and a semiarid precipitation regime. However, the high elevations provide for near alpine conditions. The nearest climatological station (elevation 3529) is at Hamilton, about 10 miles southeast of Fred Burr Reservoir Dam. Mean annual precipitation at this station is 13 inches, and mean temperature is 46 degrees F. Mean monthly precipitation varies from 0.65 inch in March to 2.06 inches in June. Mean annual precipitation at Fred Burr Reservoir basin may be near 70 inches, and temperatures may average about 15 degrees F cooler than at Hamilton.

The probable maximum precipitation (PMP), as determined from the U.S. Weather Bureau's Hydrometeorological Report No. 43 (Ref. 6), has a 1-hour value of 5.9 inches and a 6-hour value of 7.9 inches. Using a constant loss rate of 0.15 inch per hour, approximately 4,400 acre-feet of runoff can be expected from the 11.8-square-mile drainage basin during the 6-hour probable maximum flood (PMF). Because only about 280 acre-feet of surcharge is available in the reservoir between the spillway crest (with gate open) and the dam crest, and because only a small portion of the PMF can be passed by the spillway, the dam may overtop during the PMF when less than 10 percent of the flood volume enters the reservoir. If the spillway gate remains closed during the PMF, the dam may overtop when less than 5 percent of flood volume enters the reservoir. This indicates that Fred Burr Reservoir Dam will be overtopped by floods significantly smaller than the PMF.

The 100-year precipitation, as determined from the NOAA ATLAS 2 for Montana (Ref. 7), has a 1-hour value of 1.25 inches, a 6-hour value of 2.4 inches, and a 24-hour value of 4.6 inches. An estimate of the 100-year peak inflow to Fred Burr Reservoir was made from the USGS Open File Report 75-650 (Ref. 8). The method gives 500 c.f.s. (42 c.f.s./square mile) as the 100-year peak flow. However, the peak flow at a discontinued USGS gage (with 5 years of record) downstream of the dam is 45 c.f.s. per square mile. The peak flow at a discontinued USGS gage (with 17 years of record) on Bear Creek to the north is 50 c.f.s. per square mile.

The Fred Burr Reservoir Dam failed in May 1948. Accounts of the dam break flood describing observed conditions in the canyon below the dam state that a swath, several hundred feet wide in places and from a few feet to 30 feet above the stream bed, was cleared of trees and debris. The creek bed was eroded from a few feet to about 15 feet deep in places. Water marks were left 30 feet above the bottom of the channel in places, but a more average height would be 10 to 15 feet. The USGS estimated the peak dam break flow, by slope-area method, to be 23,100 c.f.s.

Dam Embankment

Plans of the original dam built in 1947 were not available, and the plans for the existing dam do not show how the original dam was incorporated into the embankment section (Plate 4). The existing dam appears to be built of sandy silt with gravels and granite gneiss. This material would be highly erodible if the dam ever overtopped, and failure would occur rapidly. The embankment surface materials appear to be well-graded and not susceptible to liquefaction caused by seismic shock.

The present dam has a 15-foot crest width and is 320 feet long. The upstream slope was measured at 1 V on 2.25 H and the downstream slope varies from 1 V on 2 H to 1 V on 4.0 H. The upstream slope is covered with 18-inch-minus riprap placed without bedding directly on the slope; however, the slope is adequately protected from wave erosion. The downstream slope is covered with 12-inch-minus rock. No erosion, irregularities, slumps, or cracks were present on the dam crest or slopes.

All information indicates that the 48-inch-diameter conduit was placed on alluvial sediments. The plans show no cutoff collars around the pipe.

Foundation Conditions, Seepage, and Drainage

Both abutments and the dam embankment are probably founded on the glacial deposits. The left abutment is covered with a rock talus that probably overlies the glacial deposits. The foundation preparation is unknown because there is no information describing the original dam and how the foundation was

prepared. The plans show that the existing dam foundation was stripped and a cutoff trench excavated 5 to 6 feet into the glacial deposits. A memorandum, dated 1949 (Ref. 4), stated that a cutoff trench 5 feet deep was excavated below the original embankment and 6 to 10 feet into the abutments.

During the July 18, 1979, inspection, with the reservoir near normal full pool, no seepage was observed. Erosion about 2 feet deep along the right side of the spillway wall was caused by surface runoff.

Stability

There is no stability information on file. The absence of seepage on the downstream slope, the use of rocky, gravelly, sandy silt for embankment construction, and the present embankment dimensions suggest that the embankment section may adequately conform to the recommended guidelines. However, sufficient information is not presently available for proper evaluation of stability.

The side slopes of the spillway entrance channel are riprapped and concrete lined, and appear stable.

Operation and Maintenance

The rancher who operates the gates was not present during the inspection, so no direct information about operation and maintenance was received. However, visual observation of the facility showed it to be generally well maintained. The gates have been greased, the embankment is free from heavy vegetative growth, and the joints of the outlet conduit have been patched. However, debris on the upstream face of the dam and against the log boom needs to be cleared, and joints of the spillway chute need to be checked and sealed. The reservoir is used to store irrigation waters. The road to the dam is rough, so the dam is not easily reached for operation, maintenance, or inspection. There is no known downstream warning plan.

Size and Downstream Hazard Potential

Since the original dam failed (May 1948) shortly after completion, a fair idea of the probable damage from a failure of the rebuilt Fred Burr Reservoir Dam can be obtained by reviewing accounts of the 1948 failure. An excerpt from an undated and unsigned memo about the failure follows:

> From the dam downstream to the west line of land owned by Wm. Amos, the creek channel was washed clear of any brush and trees. It has apparently been deepened as much as 20 feet or more in some places, and this material washed downstream, the fines apparently carried by the water

> into the Bitterroot River. The boulders, trees, and brush have been deposited in an area from about 500 feet wide to 1,500 feet wide for a length of about 2 miles. Most of this area is timber and pasture land. One property owned by Mr. Graham contained about 9 acres of oats that he had recently planted, which I understand was badly damaged. All cross fences and some parallel fences were destroyed. The only report I have of livestock loss is one beef calf owned by W. S. Bailey, although I have not confirmed this with Mr. Bailey. Due to water conditions, I was not able to contact Mr. Graham, but I was told by a reliable person that his automobile was badly damaged by the flood, also his corral fences. Other farmland in the area being meadowland was covered with water in some places with no apparent damage. The county road above mentioned is washed out in several places although the county bridge is still intact, but the creek channel is now further south and it is the desire of the county to keep it at that point which will mean the building of a new bridge.

The height of the dam is 50 feet and the maximum storage is about 690 acre-feet. The dam is classified as intermediate in size. A reconnaissance of the area downstream of the dam was conducted by Art Taylor of the State of Montana Department of Natural Resources and Conservation and by a U.S. Forest Service representative. An excerpt from Mr. Taylor's memo (Ref. 2) of the reconnaissance follows:

> The valley below the dam is a narrow canyon in the first 5-1/2 miles with much vegetation, mostly large trees. The creek is in a wide valley for the remaining 7 miles. There are two houses below the dam which are about 20 to 30 feet above the stream bed. There is a large subdivision being built to the north of the creek in sections 14, 15, and 16 of Township 7 North, Range 21 West. These lots appear to be well above the floodplain.

The two houses described in Mr. Taylor's memo are located in the wide valley flood plain below the canyon. Because of their location and our judgment that a dam break flood wave would be significantly attenuated by the wide valley, we recommend that the dam be classified as a low hazard structure. However, it should be periodically reevaluated, since future development near the creek may be affected by a breach of Fred Burr Reservoir Dam.

Recommendations

1. Conduct more detailed hydrologic and hydraulic routing studies to better determine the downstream hazard and required spillway capacity, and modify the project as studies indicate.

2. Conduct periodic inspections of Fred Burr Reservoir Dam at 5-year intervals by engineers experienced in dam design and construction. Also, conduct these inspections on Fred Burr Lake Dam upstream, because its failure could cause overtopping and failure of Fred Burr Reservoir Dam.

3. Inspect the entire length of the outlet conduit, and repair it as required.

4. Divert surface drainage into the reservoir or otherwise control it to prevent serious erosion during a high runoff event.

5. Embankment stability may conform to the inspection guidelines; however, as there is no information on foundation or embankment materials, evaluation is not possible.

REFERENCES

1. U.S. Army Corps of Engineers, Office of the Chief of Engineers Report to the U.S. Congress, National Program of Inspection of Dams, Vol. 1, Appendix D, "Recommended Guidelines for Safety Inspection of Dams," Washington, D.C., Department of the Army, May 1975.

2. Art Taylor, State of Montana Department of National Resources and Conservation, Memorandum to the Record, August 28, 1979.

3. Richard D. Eckerlin, U.S. Army Corps of Engineers, Memorandum on Fred Burr Reservoir, August 1979.

4. S. T. Algermissen and D. M. Perkins, "A Probabilistic Estimate of Maximum Accelerations In Rock In The Contigious United States," Bulletin, U.S. Department of the Interior, Open file report, U.S. Geological Survey, No. 76-416, 1976.

5. P. A. Ingebo, United States Government, Office Memorandum on Fred Burr Creek Reservoir, June 9, 1948.

6. U.S. Weather Bureau, Hydrometeorological Report No. 43, "Probable Maximum Precipitation, Northwest States," Washington, D.C., 1966.

7. National Oceanic and Atmospheric Administration (NOAA) Atlas 2, Precipitation-Frequency Atlas of the Western U.S., Volume 1 Montana, 1973.

8. U.S. Geological Survey Open File Report 75-650, A Method for Estimating Magnitude and Frequency of Floods in Montana, January 1976.

APPENDIX

DEPARTMENT OF NATURAL RESOURCES
AND CONSERVATION
WATER RESOURCES DIVISION

THOMAS L. JUDGE, GOVERNOR
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STATE OF MONTANA

(406) 449-2872
HELENA, MONTANA 59601

June 11, 1980

Department of the Army
Seattle District, Corps of Engineers
P.O. Box C-3755
Seattle, WA 98124

Attn: Ralph Morrison

Re: CH$_2$M Hill Dam Safety Inspection Memorandum on Fred Burr
Reservoir Dam (MT-763).

Dear Ralph:

We have reviewed the above referenced final draft memorandum and concur with the findings and recommendations. We offer the following comments:

On Page iv, v, and 2 what is the recommended SDF.

On Page 8, undercutting of the outlet floor slab is mentioned but there are no recommendations for repair.

On Page 10 the PMF volume is discussed and the 100-year precipitation is discussed, but no mention is made of the 100-year flood volume.

On Page 15, recommendation #4 should be clarified as to where the potential erosion areas are.

Minor editorial comments have been discussed with your staff, and we understand these will be incorporated in the final report.

Thank you for this opportunity to review and comment on the final draft memorandum on Fred Burr Reservoir Dam.

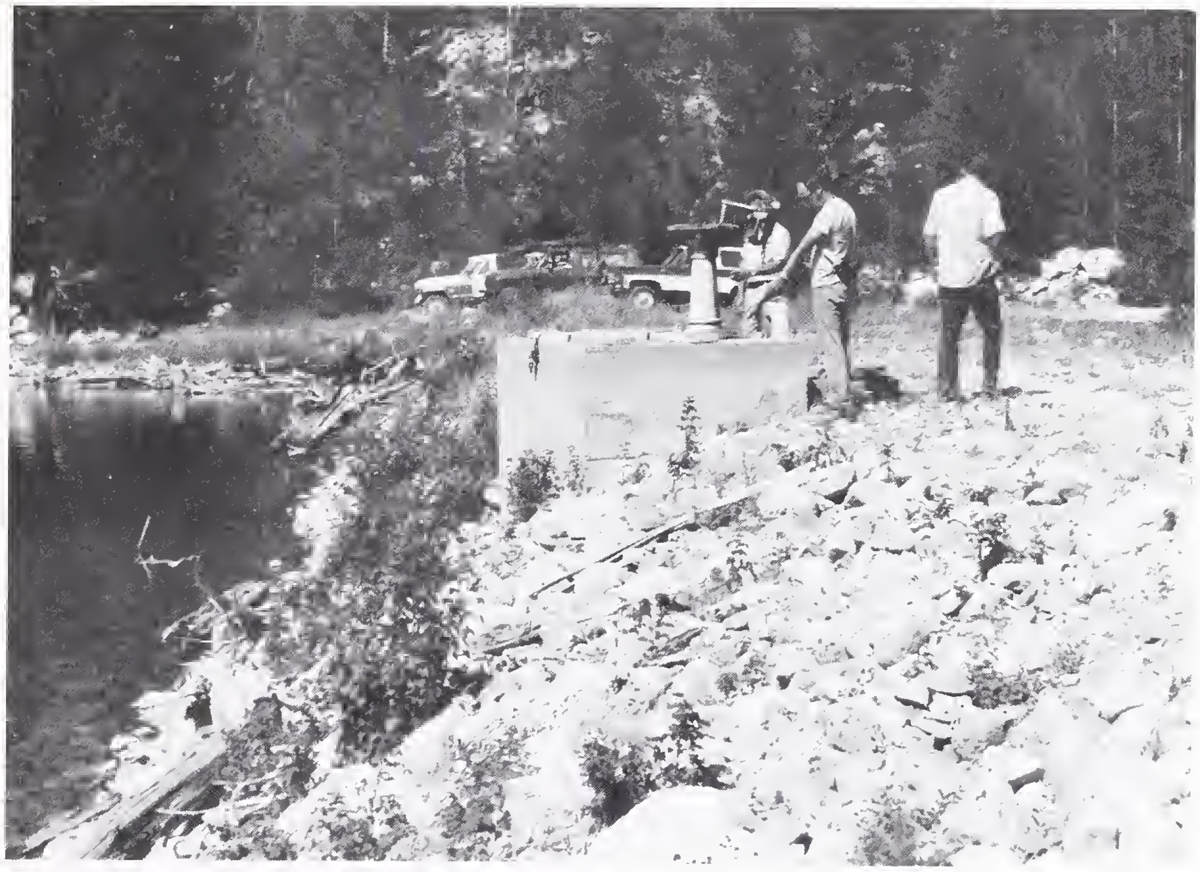
Sincerely,

Richard L Bondy

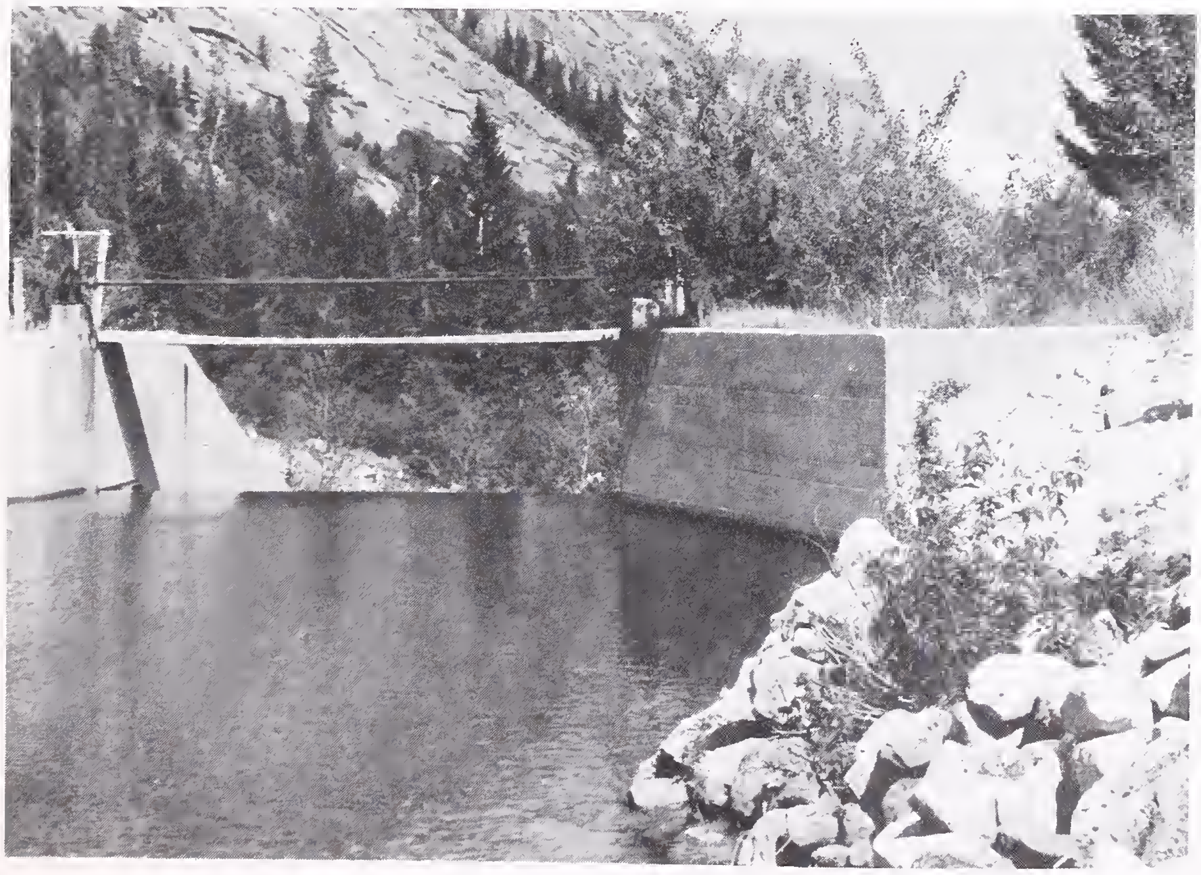
Richard L. Bondy, P.E.
Chief, Engineering Bureau

RB/AT/mb

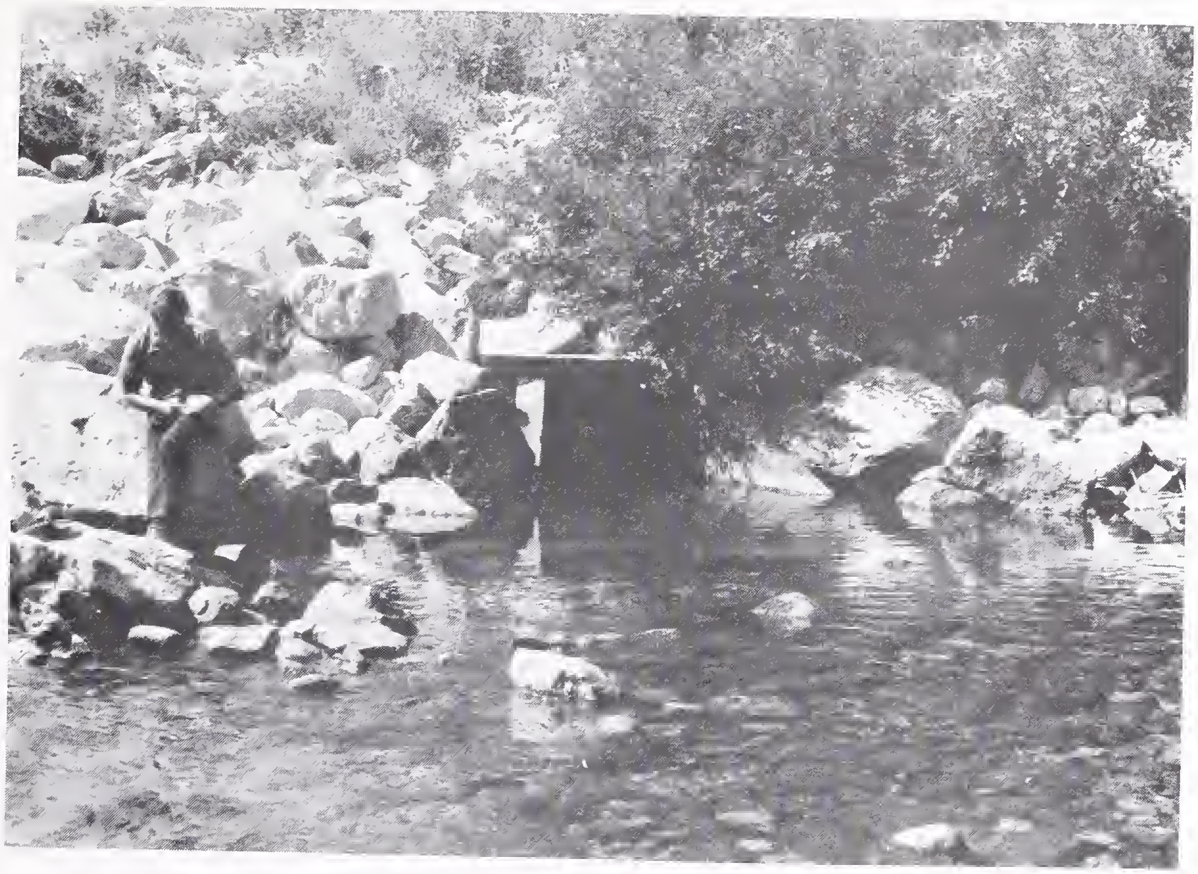
"AN EQUAL OPPORTUNITY EMPLOYER"



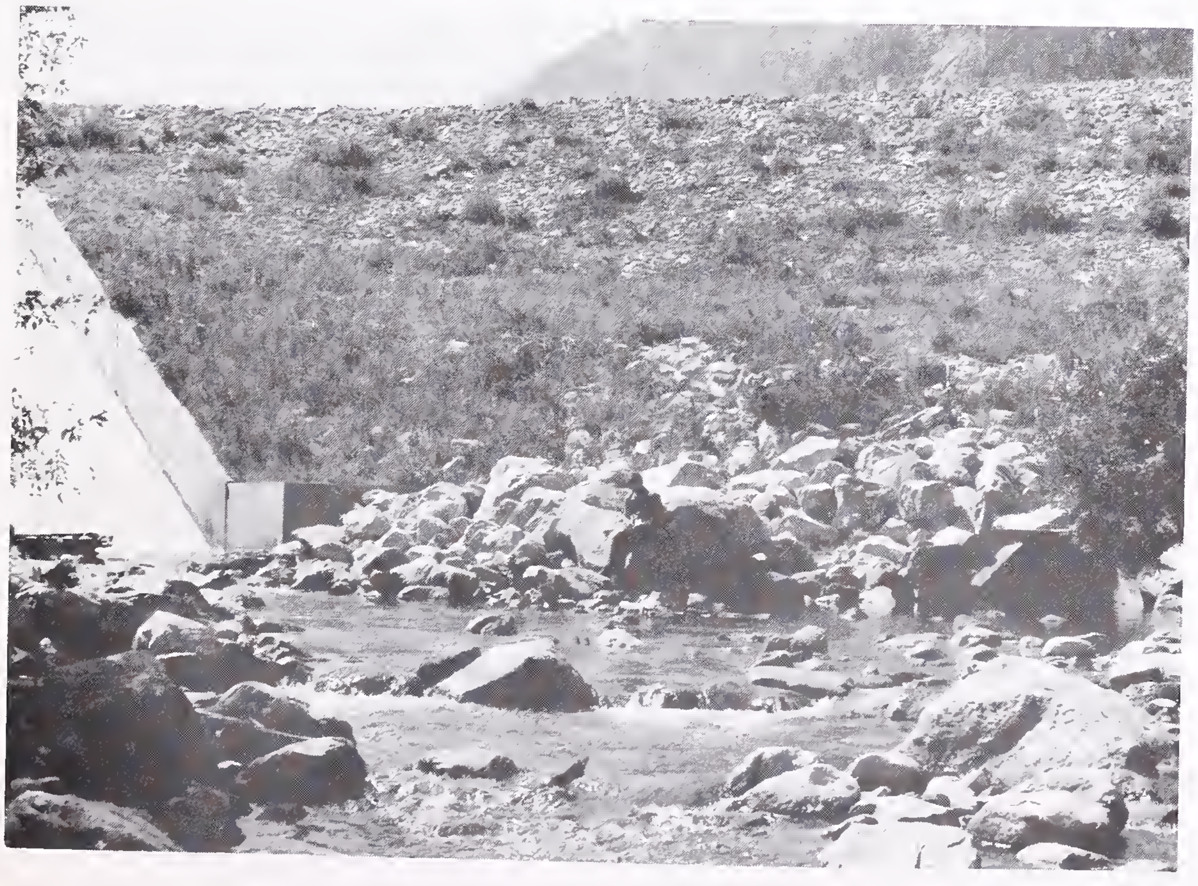
1. .FRED BURR RESERVOIR DAM
(MT-763)
18 JULY 1979
Outlet Control Structure



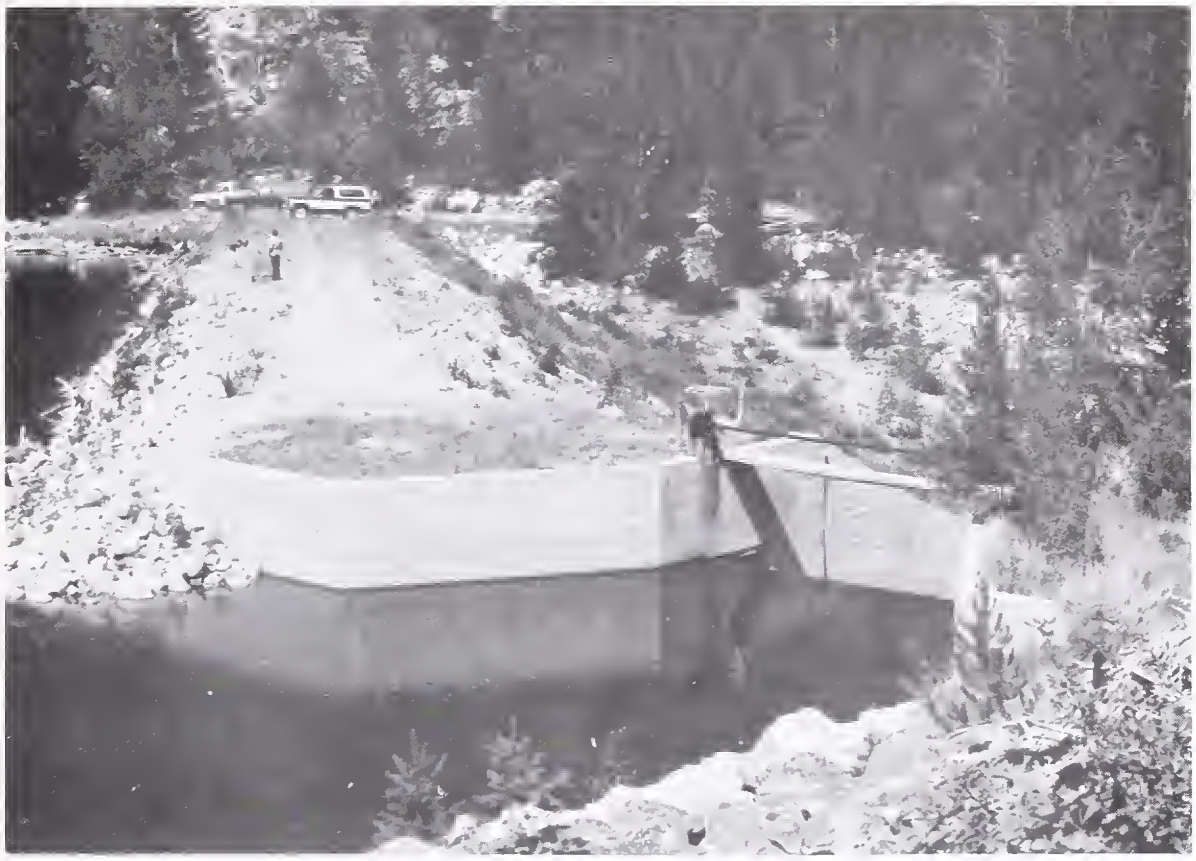
18 July 1979
2. Spillway Entrance



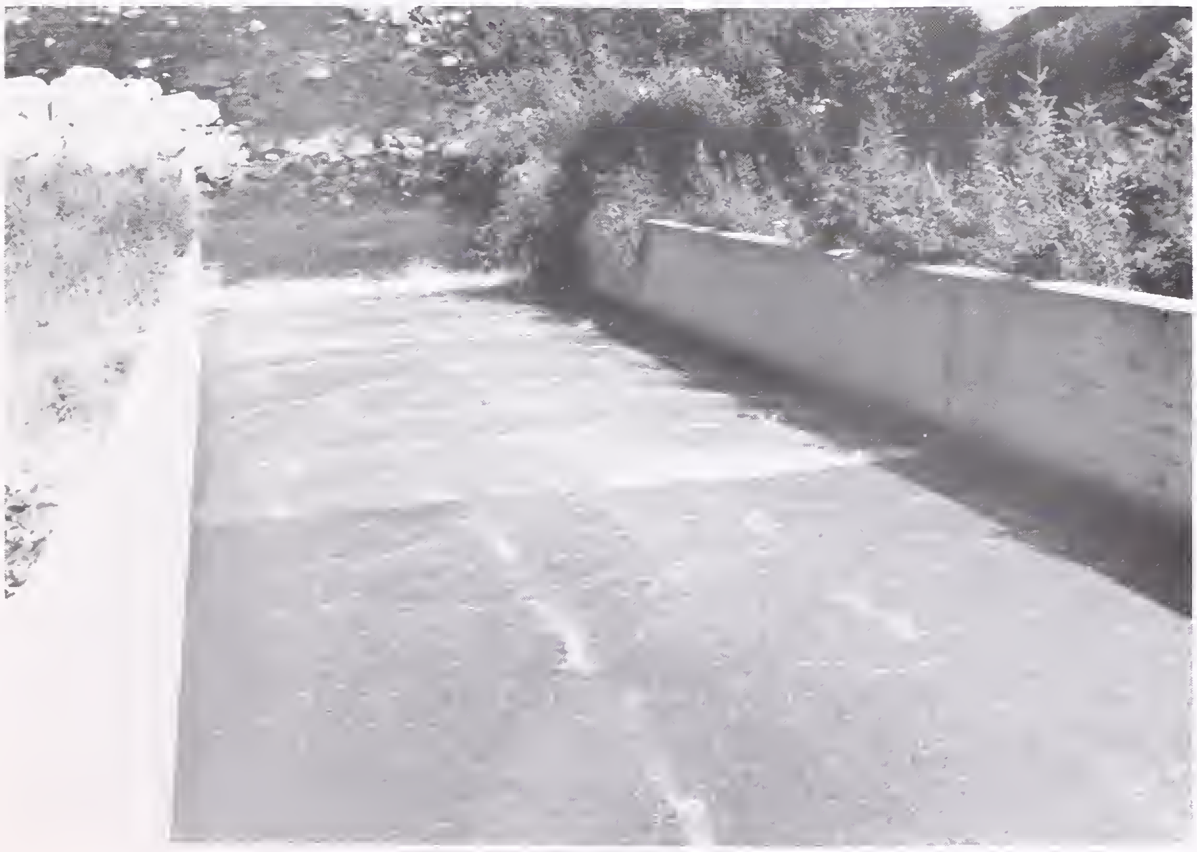
FRED BURR RESERVOIR DAM
(MT-763)
18 JULY 1979
3. Discharge end of outlet conduit



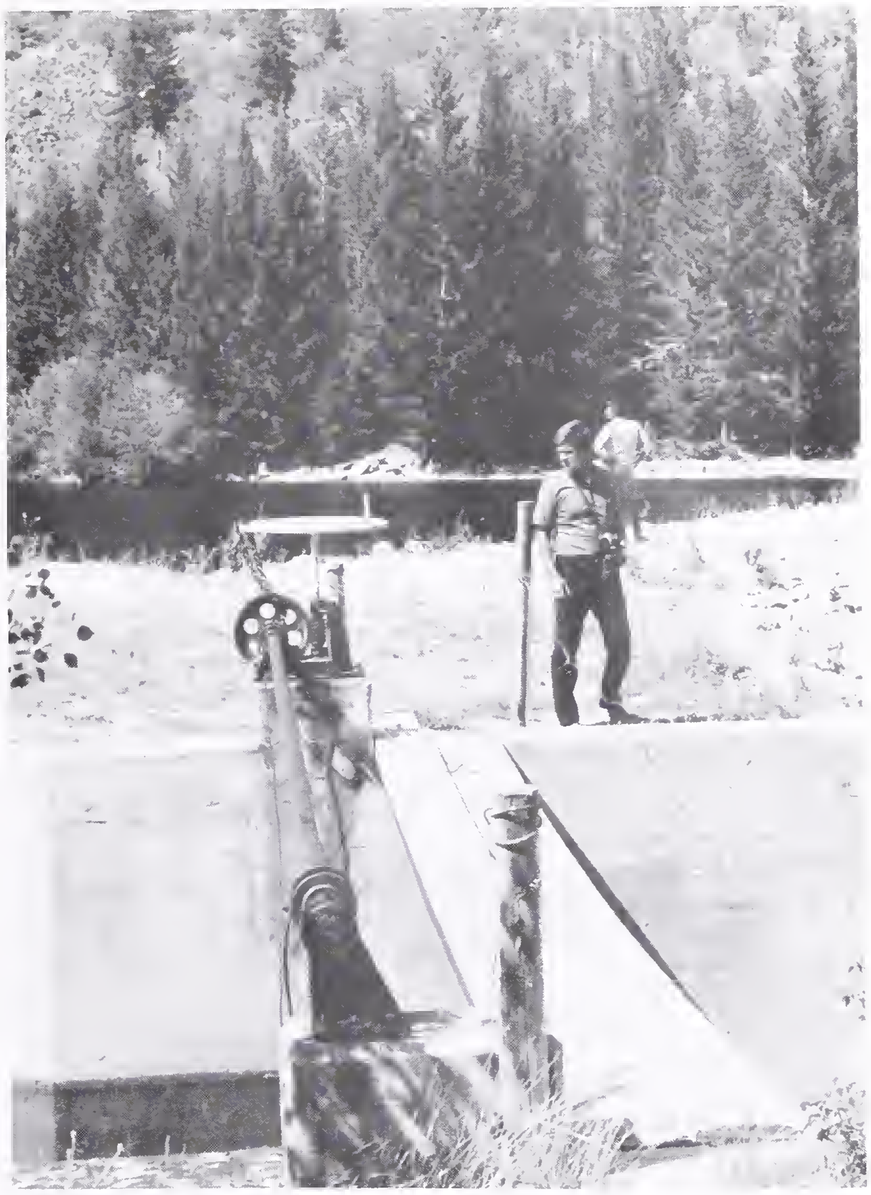
18 JULY 1979
4. Spillway, embankment, and outlet conduit
Note: Riprap along toe of Dam
Downstream of spillway



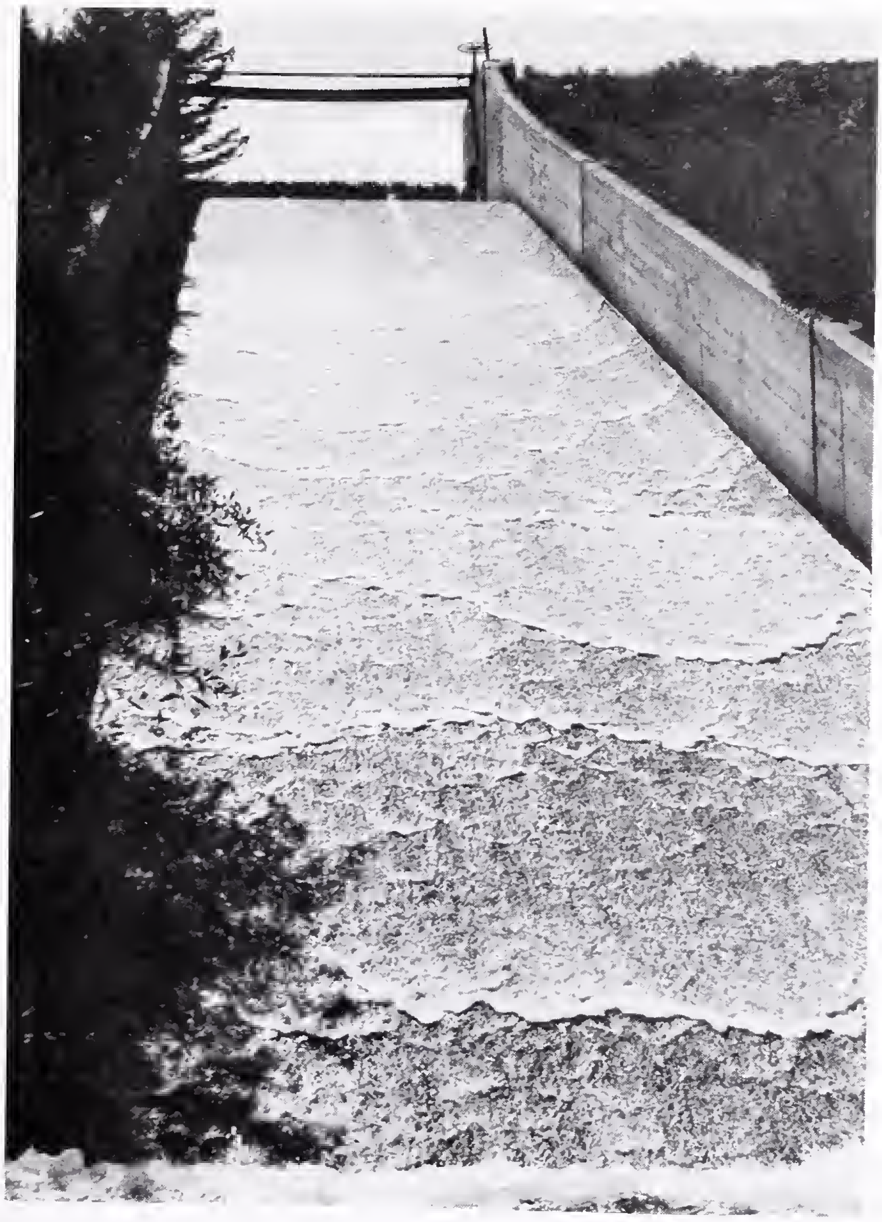
FRED BURR RESERVOIR DAM
(MT-763)
18 JULY 1979
5. Dam and Spillway



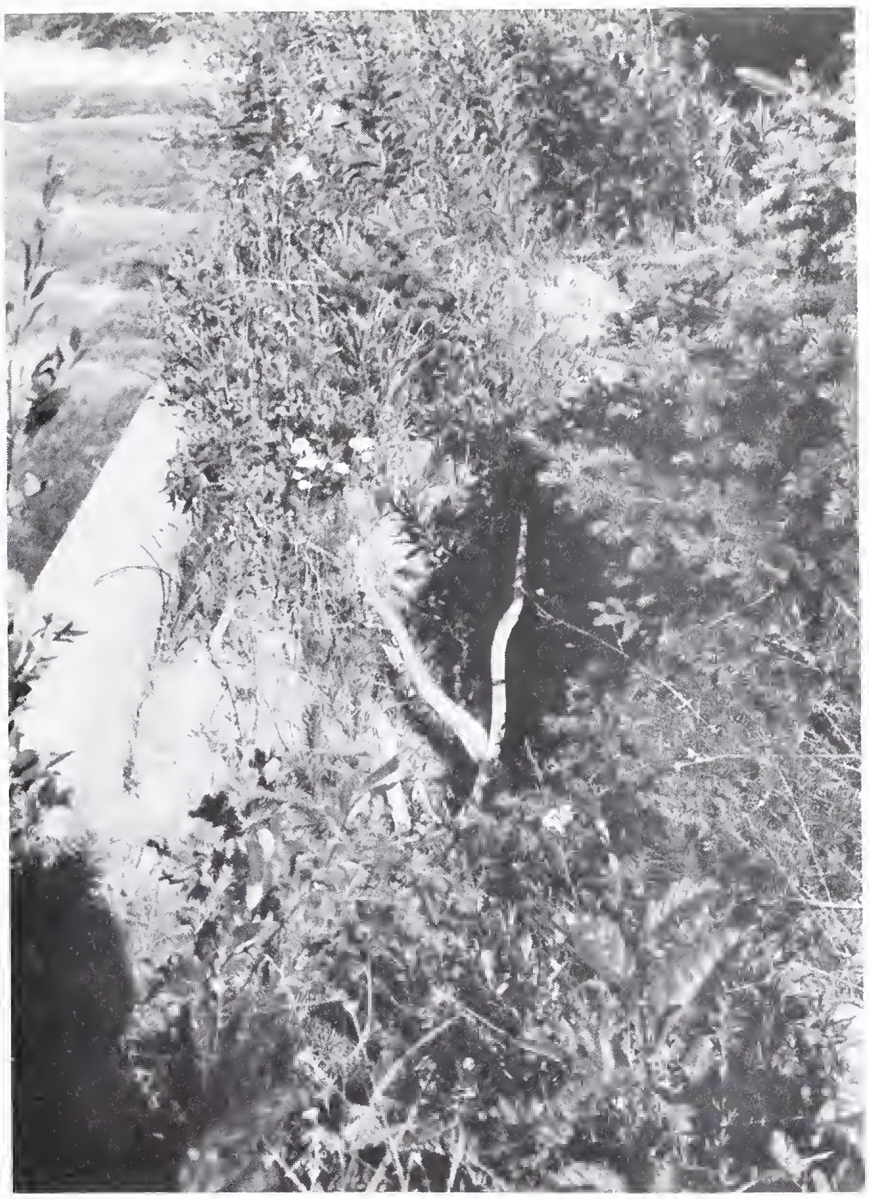
18 JULY 1979
6. Looking down spillway chute



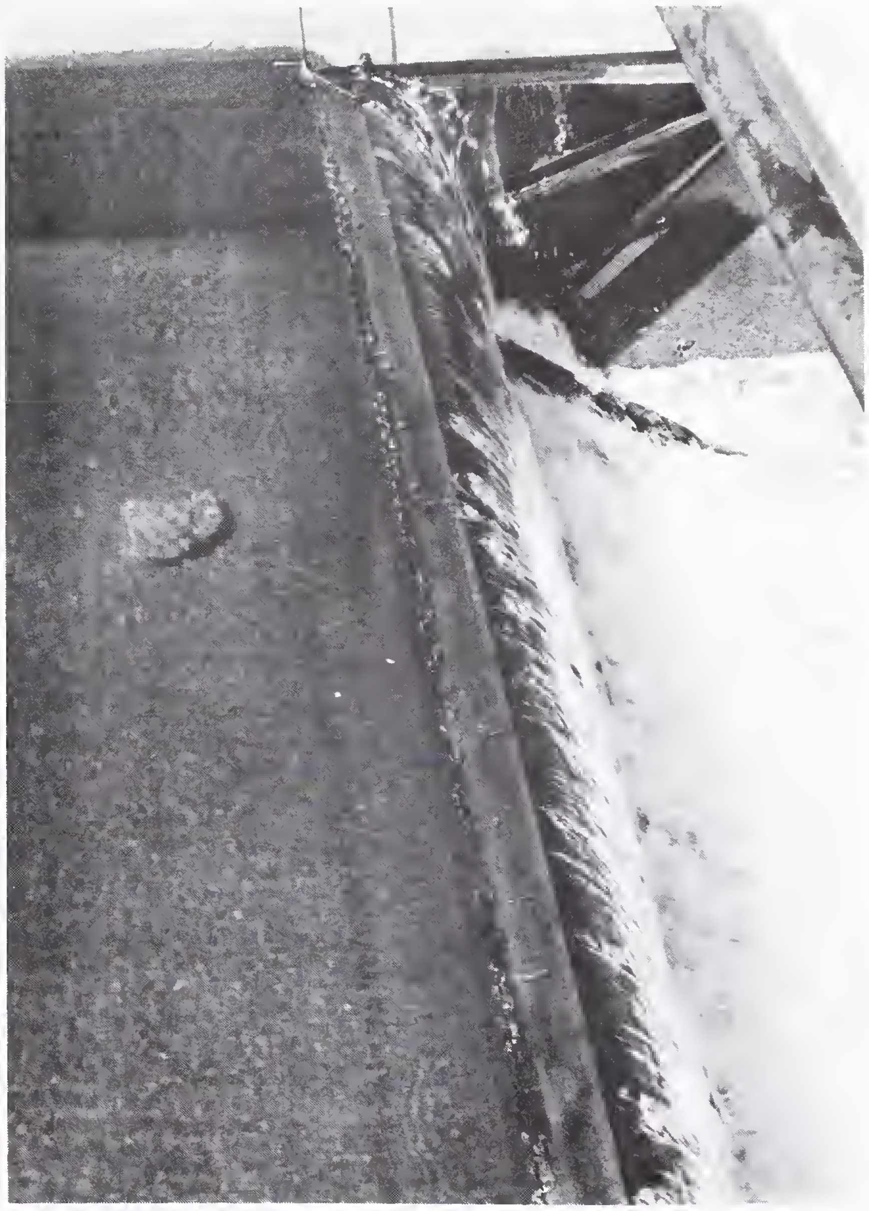
FRED BURR RESERVOIR DAM
(MT-763)
18 JULY 1979
7. Gate Control for Spillway Gate



FRED BURR RESERVOIR DAM
(MT-763)
18 JULY 1979
8. Looking up spillway chute



FRED BURR RESERVOIR DAM
(MT-763)
18 JULY 1979
9. Erosion from surface drainage along right spillway wall (looking downstream)



FRED BURR RESERVOIR DAM
(MT-763)
18 JULY 1979
10. Spillway gate

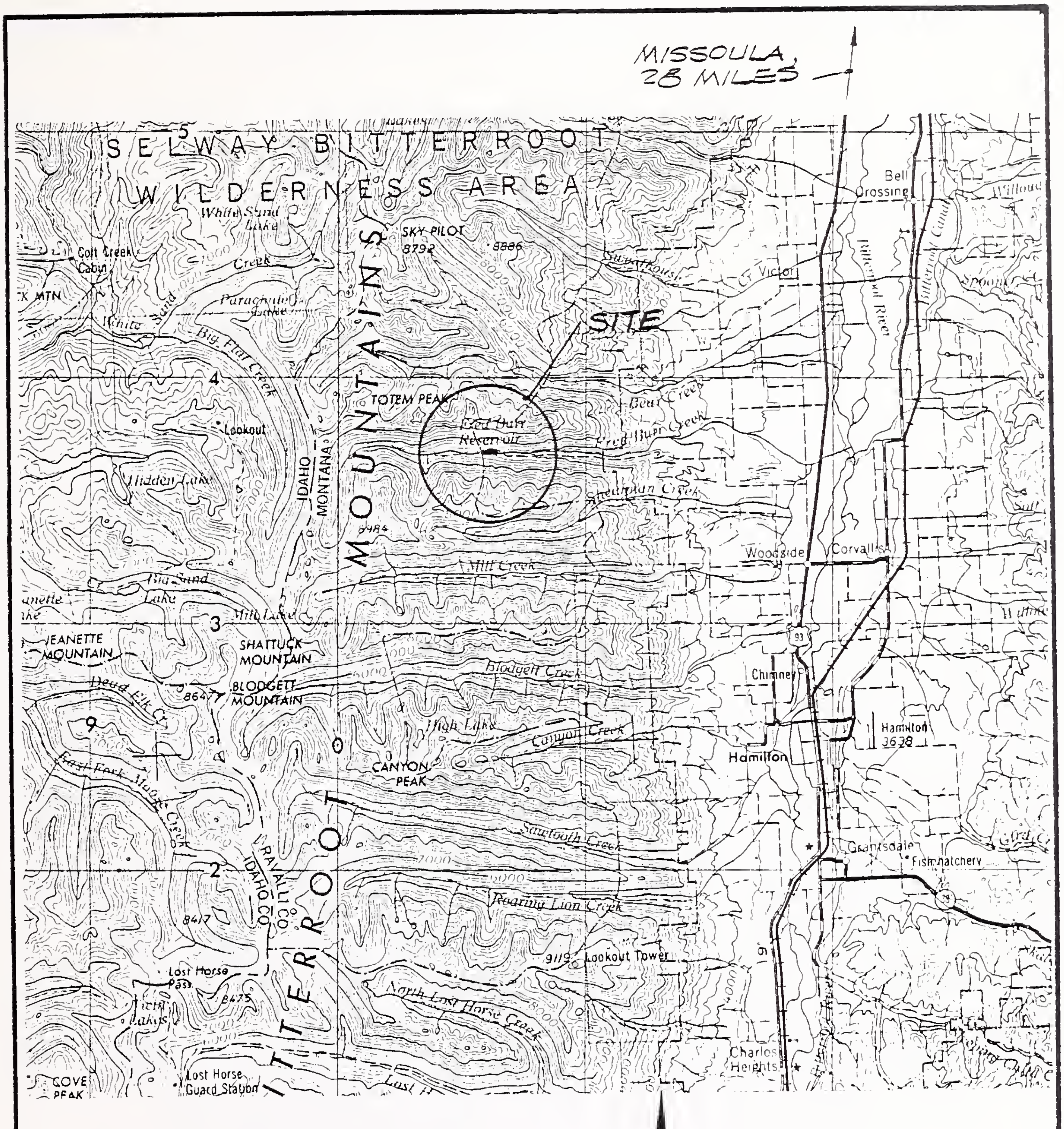


PLATE 1

FRED BURR RESERVOIR
VICINITY MAP

CH2M HILL

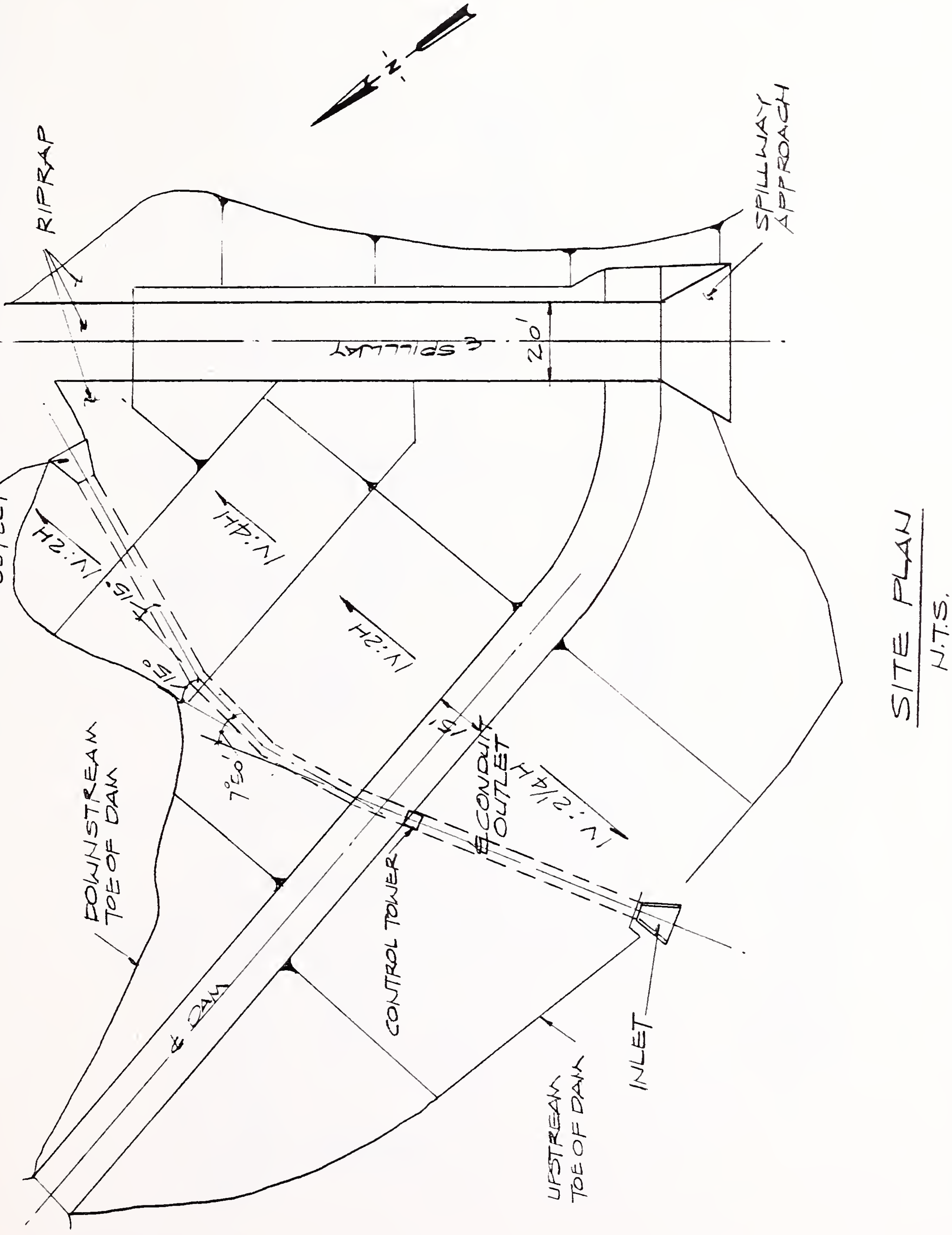
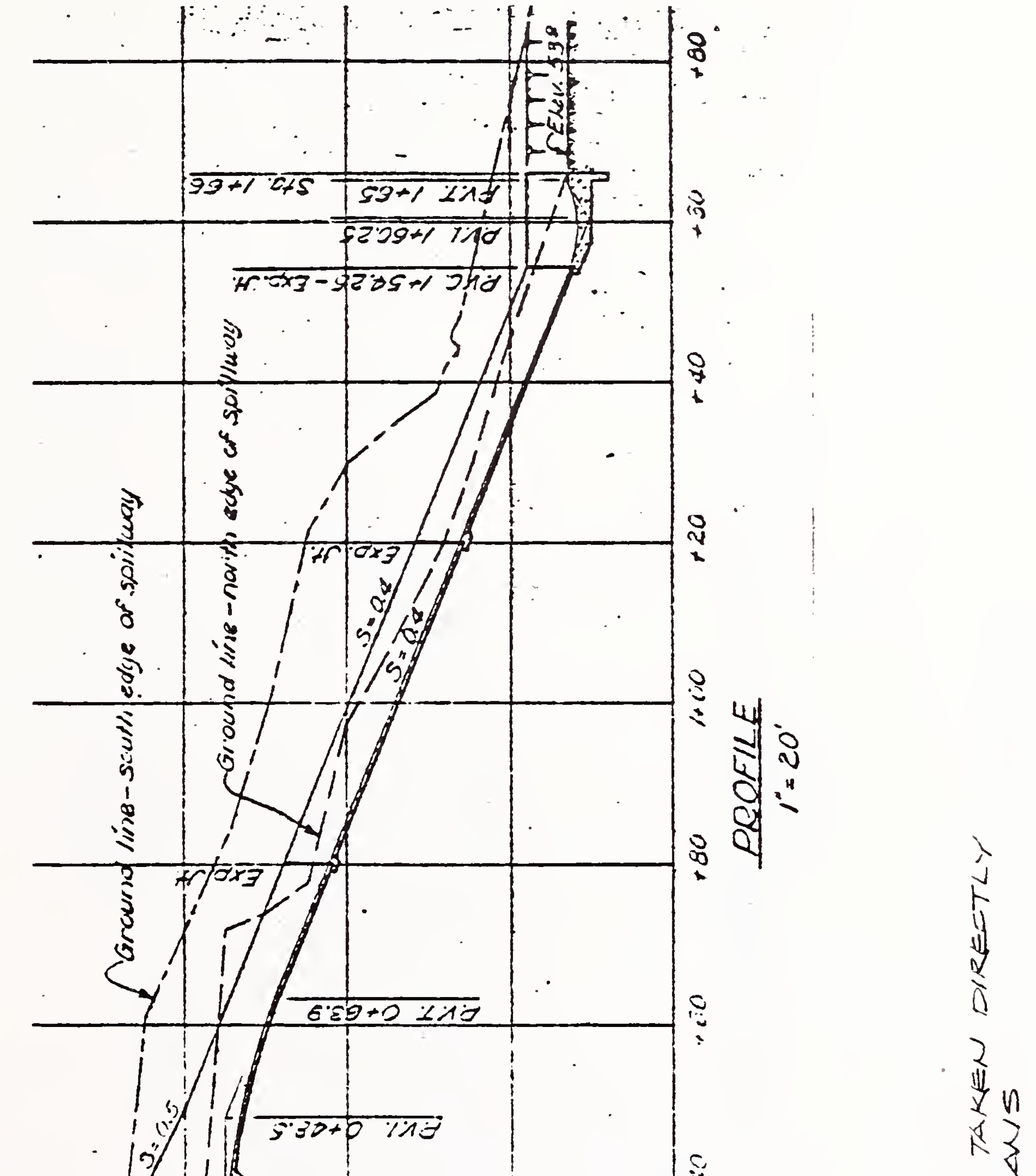


PLATE 2

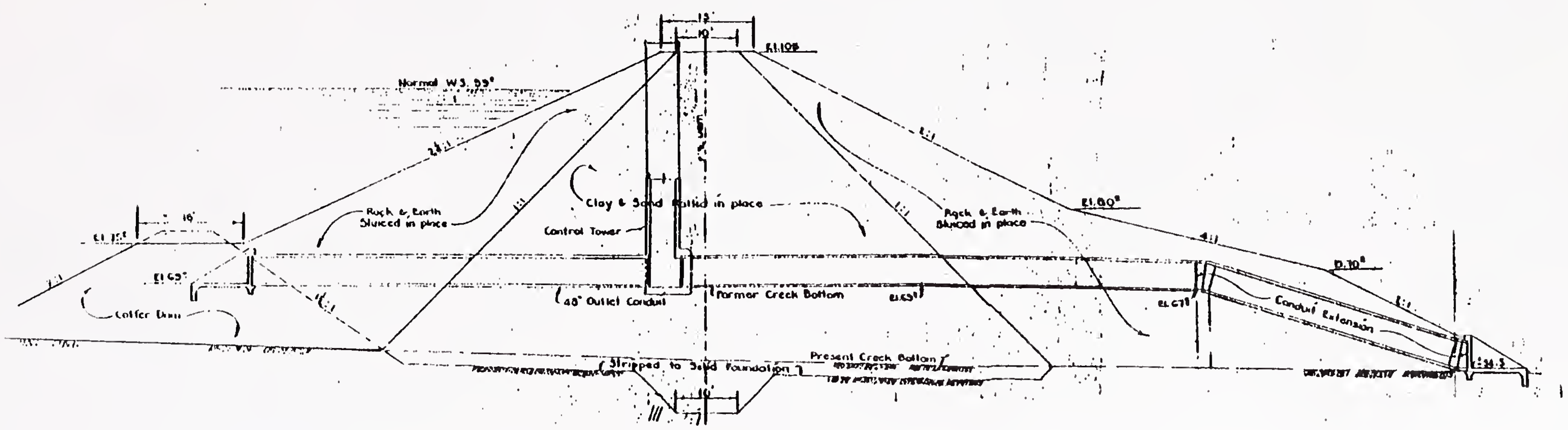
FRED BURR RESERVOIR
SITE PLAN



NOTE:
DRAWING TAKEN DIRECTLY
FROM PLANS

PLATE 3

FRED BURR RESERVOIR
SPILLWAY PROFILE



DAM EMBANKMENT SECTION

N.T.S.

NOTE:
DRAWING TAKEN DIRECTLY
FROM PLANS

PLATE 4

FRED BURR RESERVOIR
DAM EMBANKMENT SECTION

CH2M HILL